Key Factors that Enable Product Development:

An Investigation of Creating "Cool" Products

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The CAR-Microsoft Program on Automotive Industry Practices is a four-year research effort consisting of in-depth, focused interviews with industry participants on subjects of importance to all industry stakeholders. The Automotive Industry Program, funded by Microsoft, will investigate two topics per year, with results publicly disseminated.

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Finally, this report is the result of several people contributing in many ways. The authors of this report would like to thank Karen Esper, who contributed by formatting and managing the document. Chris Powers and Raymond Miller assisted in the interview process and document review.

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Executive Summary

The Center for Automotive Research has undertaken the CAR-Microsoft Program on Automotive Industry Practices. The program is a four-year research effort consisting of in-depth, focused interviews with industry participants on subjects of importance to all industry stakeholders. The intent of this paper is to investigate how different companies have adapted their product development processes to the changing competitive climate and how they utilize new technologies (e.g., weblogs, internet chat rooms, and other such digital communications) to transform their vision into products. The focus is not on the tools or the specific strategies, but rather on the information channels product design teams use for inspiration and understanding the market and on how the product design teams work together to create "cool" products.

This report uses case studies—three automotive and one non-automotive—to illustrate how companies have attempted to proactively create innovative products. Given the relatively small number of interviews, this report is not intended to provide a complete description of the topic. Instead, by selecting companies that are thought leaders in a specific topic, CAR hopes these case studies will be viewed as indicative and that the conclusions drawn will contribute to the greater understanding of the issues and challenges.

Case 1, called the Player, involved a consumer electronics product. The most innovative method of collecting user data was through the use of an interactive service where the product team (for both hardware and software) used the service to interact 'live' with the end user. This gave the team clear insight into specific strengths and weaknesses of the original product, and allowed them to make design changes. The team also used the service to capture and plug holes after product launch. This was a case of a product development system in transition from skunk-works to a more structured process. The challenge was to develop a process with small company speed and innovation, but with large company product development controls. The team adopted a structured approach to the overall project, but retained the small team feel by dividing the team into subgroups. The key enabler for this strategy was the strict adherence to a web-based product reporting system.

Case 2, called the Rebel, involved a major OEM where the corporate culture actively promoted irreverence to the past, revolutionary thinking and "breaking the rules." This led to a small company culture within each product development team, who were all empowered to look and then do things differently. Thus, the challenge for this company was to manage tension in the product and the development process. They used market focus groups to identify styling elements that created tension—customers either loved it or hated it, indicating a strong emotional response. Balancing the market research was a healthy reluctance to rely too heavily on extensive data analysis, as it ran counter to the small company culture of nimbleness and rapid response to market changes. The rebel team also credited their suppliers for having a significant role in creating these designs. Successful OEMs involve their suppliers early and develop a process and infrastructure that inspires them to innovate and enables them (and the OEMs) to adapt quickly to changes in technology and the market. Successful suppliers are developing and selling new technology that allows radical styling changes such as LED headlights, ultra thin seats, and transparent roofs. The Rebel design teams also used blogs and on-line interviews with

fans. This created a feeling of closeness between the customer and the designer. "There is nothing cooler than being able to chat with the designer of your favorite car."

Case 3, the Fast Follower, used traditional data gathering channels, such as competitive benchmarking. They believe some companies choose benchmarks that are too easily attained, and thus deliver a vehicle that does not reach beyond the competition. They would choose lofty benchmarks, (e.g., select a luxury car as the bogey for a mid-class sedan), to instill a stress in the organization and push the development team to create better, cheaper vehicles and components, faster. Two other elements helped them achieve the agility and speed of a small company. First, they were driven by a culture of being the underdog. There was a constant pressure to 'catch' the competition and deliver better, less expensive alternatives. This led to an innate appreciation of speed throughout the organization. Second, the company had what was described as a no fault attitude. Making decisions rapidly was viewed as important, but identifying and rectifying problems and errors quickly was equally important. The culture was to reduce—even eliminate—the fear of blame, and replace it with an atmosphere of identifying errors and correcting them as quickly as possible.

Case 4, the technology push team worked with the customers on their installations and actually "walked the walk." They performed the work first at the customer's location. This gave them first hand experience in what the customer had to do every step of the way. Not only did they experience how well their product performed (or did not perform), but they also gained an understanding of the true problems the customer faced and why the customer was doing this particular task or work. This, in turn, provided them insight to the purpose of the work at the next higher level. Based on this insight as well as explicit feedback from customers on how their products were being used, they would improve and expand their product and services. They had a passion to expand the system by always looking at ways to add value; they continually attempted to perceive the next level of use. They focused not only on the immediate tasks and technology, but also on the higher level purpose, the processes, and the people. While this approach does not rely heavily on a web-based communication or technology, it does allow the company to obtain a truly deep understanding of the customer at all levels.

The major themes that emerge from the four cases are:

- Size matters - all product development teams behaved like small, nimble entities. This enabled faster communication as well as innovative and risk-taking behavior.
- Variety of information channels – respondents established different information channels such as focus groups, competitive benchmarking, and direct internet-based customer interaction to obtain a deeper understanding of the unstated customer needs and desires.
- Data is not everything – the data-driven design process of the '90s is out. A decisive leader with product passion and customer awareness is key.

A successful company must create a corporate culture that elicits the nimble and agile behavior of a small company, within the team, without stifling it with the larger company's need for control. It must initiate innovative information channels to better develop a deep understanding of the customer through direct interaction with individual designers on the product development team. And it must develop the infrastructure to identify, groom, and retain leading personnel for the chief engineer's position.

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INTRODUCTION

The Center for Automotive Research has undertaken the CAR-Microsoft Program on Automotive Industry Practices. The program is a four-year research effort consisting of in-depth, focused interviews with industry participants on subjects of importance to all industry stakeholders. The Automotive Industry Program will investigate two topics per year, with results publicly disseminated. The first topic of investigation was warranty in the automotive industry. The second topic is investigating some key product development factors that enable "cool" design.

It is understood that many aspects in addition to product design, such as manufacturing (quality) and marketing, are involved in creating a successful or great product. This paper focuses on great products that created a ***'market buzz'*** instead of products where ***'marketing created buzz'***. The distinction is similar to market-pull versus market-push. Market-pull is created by designing and engineering a product that meets, in an authentic way, the needs of a core group of users. The success of a product is reliant on meeting that authenticity test—that is, do the core users feel it meets, and even exceeds, their needs. While this core user group can make or break a product, the truly innovative products can transcend their core user group to gather attention from a wide variety of non-traditional users. Conversely, a product can also gain acceptance through a strong marketing campaign—a marketing-push. This study did not attempt to investigate those products that gained market position based on a strong marketing program. Instead it investigated products that the market has identified as innovative and "cool".

The automotive industry is currently under enormous economic and political pressures, and companies are responding in radically different ways. This combination of pressures and responses is transforming the industry. From economic pressures such as high raw materials prices, (e.g., steel and petroleum), and countries offering low-cost labor to responses such as outsourcing, industry consolidation, and assembly flexibility, no organization can afford to remain static in any of its operations. While manufacturing played a dominant role in the 1990s and still is important today, product development is seeing a resurgence in terms of its importance within the organization. Yet, product development is under the same pressures as manufacturing to produce exciting, innovative, cost-effective designs in a short period of time.

To put the study in perspective, it is important to recognize that the automobile is becoming more complex. Market and social forces are driving the industry to create vehicles with higher levels of performance. This applies not only to their traditional purpose of safely transporting drivers and passengers, but also to the driving experience itself. Technology changes are occurring in every aspect of the vehicle. Innovation in powertrains is occurring everywhere ─from fuel efficient internal combustion engines, clean diesels, and hybrid engines to alternative fuel engines and fuel cells. The number of computer chips and software-controlled systems is increasing. The inclusion of telematics and communication technologies─both within and outside the vehicle─is growing, from recording vehicle data to navigation and entertainment systems to continuous electronic communication on demand (e.g., OnStar and web-enabled vehicle communication). This situation creates complexity─not only because the systems themselves are complicated, but also because the interaction between the systems is often

difficult to understand and predict. Further, while the market forces demand these systems, they must be designed and produced at lower cost.

In addition to the market forces mentioned above, additional factors are driving the industry to structural changes. The industry is getting more efficient, and market share is shifting between companies. This factor has led to overcapacity in the industry, which in turn leads to consolidation. Further, in an effort to lower cost, companies are outsourcing the manufacture (and to some degree the design of subsystems) to suppliers. These suppliers are generally overseas, are quite competent and have a lower cost structure. Companies are also investing overseas to capitalize on growing market opportunities. These cost pressures are not expected to abate any time soon.

Lastly, what many feel, but perhaps do not appreciate, is that all the various forces and factors are changing at an ever-increasing rate. This speed of change, with the increase in structural complexity brought about through the global economies, creates a challenge for organizations to overcome their inherent inertia and respond. Increased speed is apparent in the ever shorter product development times. The current development time for a new platform cycle is estimated to be between 29 to 34 months, depending on the OEM. This time is expected to get shorter, approaching 23 to 26 months for a new platform (see Figure 1) and 17 to 21 months for a carryover platform, by 2014 (see Figure 2). The gap between competitors is expected to continue to narrow—providing further evidence of the extreme competition in the industry (OSAT, 1998; CAR, 2005).

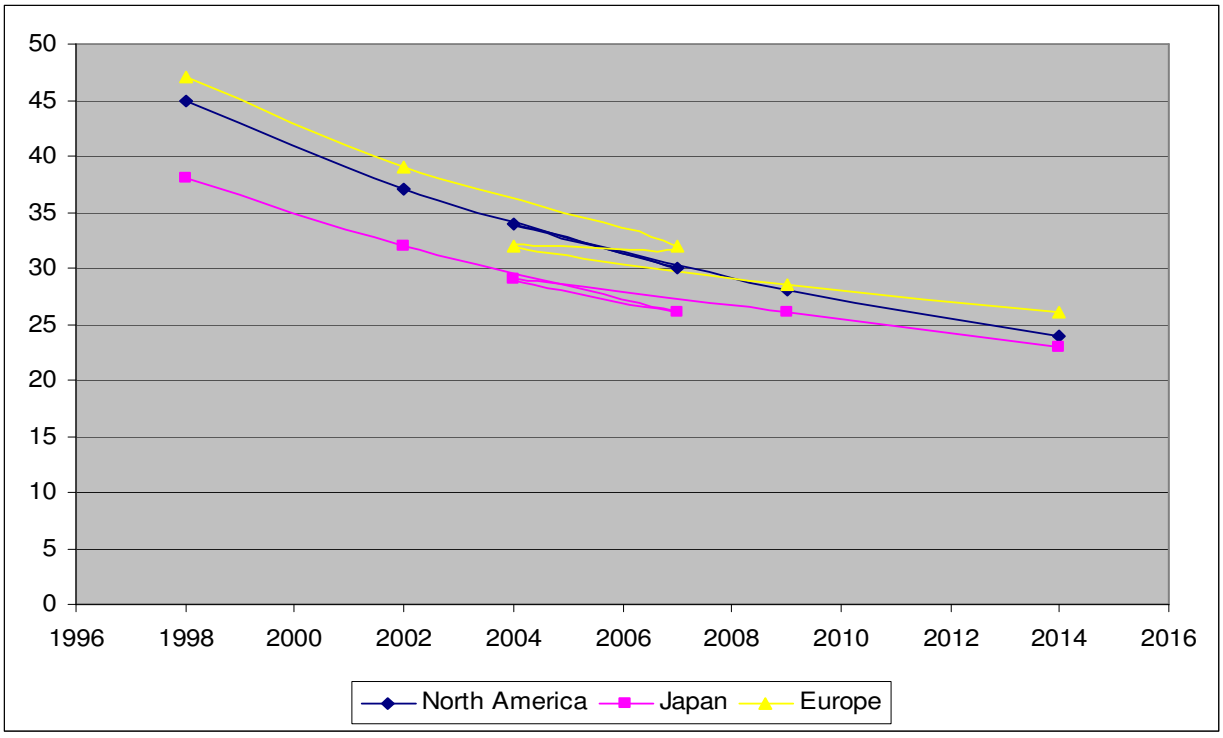

Figure 1. Median Trends for the Total Development Time of a New Platform from the 1998 and 2005 Delphi Product Design and Development Delphi (OSAT, 1998; CAR, 2005).

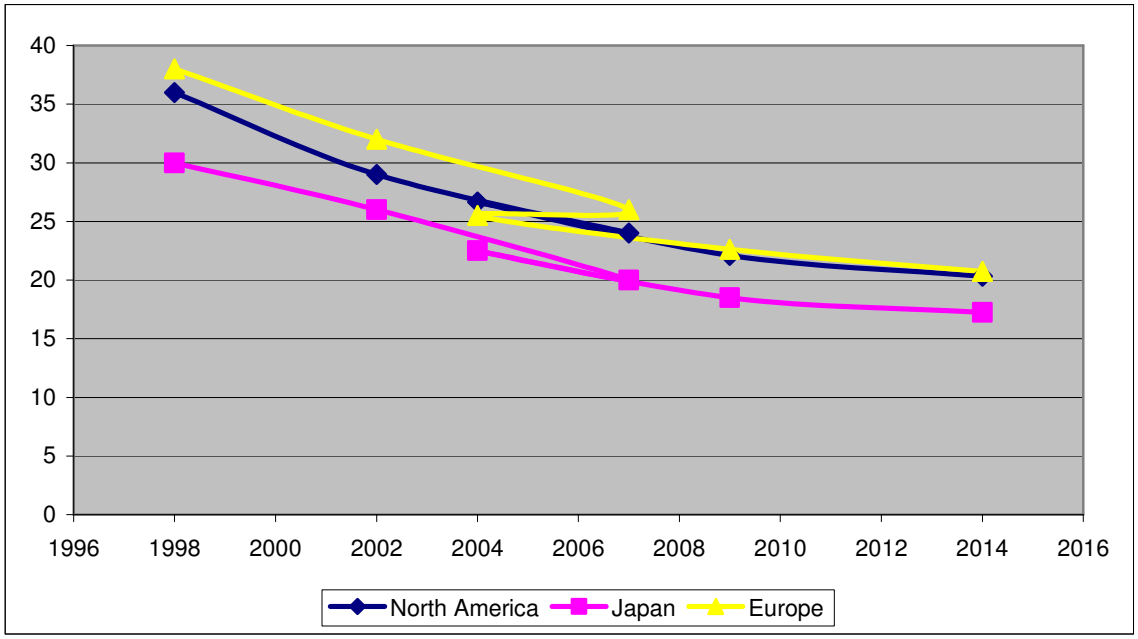

Figure 2. Median Trends for the Total Development Time of a Carryover Platform from the 1998 and 2005 Product Design and Development Delphi (OSAT, 1998; CAR, 2005).

Historically, the product development process transitioned from being heavily influenced by specific individuals in the '60's and '70s to being influenced by data-driven cross functional engineering teams in the '80s and '90s. The understanding of the speed to market concept required that everyone develop simultaneous engineering systems. Further, the data-driven mentality of the quality movement was pushed in product design. This led to the rise of many different product design methods and tools that were either focused on increasing simultaneous engineering—such as design for manufacturing and assembly (DFMA)—or were heavily data driven—such as design for six sigma (DFSS).

Since that time, there have been tremendous structural changes in the industry (globalization, outsourcing, industry consolidation, hyper-competition, etc). Thus, as the industry and individual organizations are experiencing and managing these tremendous changes, product development, too, is changing. Organizations are adopting a number of different strategies to become more lean and agile in product development. They are: increasing the number of carry-over parts and subsystems, increasing the use of modular designs, increasing the use of CAE and simulation, and increasingly designing globally for global manufacturing.

This paper attempts to highlight some of the factors that are relevant to product development today. How has it changed from the development processes of the 1990s? Companies now have access to an enormous amount of consumer information; much of this is in forms that are relatively new, (e.g., web logs, internet chat rooms, and other such digital communications). Are companies using this type of information, and if so, how? The intent of this paper is to investigate how different companies have adapted their product development processes to the changing competitive climate as well as how they have utilized new technologies to transform their vision into a product. The focus is not on the tools or the specific strategies, but rather on

the information channels product design teams use for inspiration and understanding the market and on how the product design teams work together to create "cool" products.

THE CASES

As the industry becomes ever more competitive, the process of identifying consumer needs and creating innovative products to fill those changing requirements becomes more important and complex. This report uses case studies—three automotive and one non-automotive—to illustrate how companies have attempted to proactively create innovative products. By highlighting case studies, this report will illuminate different approaches to product development. The companies were chosen because they had gained a reputation for hitting a home run with a recent product or products that the market identified as "cool".

As with many CAR projects, the identity of companies interviewed will not be made available—nor will information be presented in a way that may directly identify any participating companies. CAR researchers interviewed representatives from four companies. Given the relatively small number of interviews, this report is not intended to provide a complete description of the topic. Instead, by selecting companies that are thought leaders in a specific topic, CAR hopes these case studies will be viewed as indicative and that the conclusions drawn will contribute to the greater understanding of the issues and challenges.

Case Study 1 – The Players

The following case study involves a consumer electronics product. A key intent of this paper is to investigate products for which users have a strong attachment, and to better understand how that relationship is nurtured. For those familiar with the passion and (sometimes) loyalty of consumer electronics users, it is apparent that the connection to some consumer electronics products is strong. The brand loyalty gained by innovative consumer products is the envy of many within the automotive business.

The Case 1 product was chosen, in part, because it offers a unique form of interaction with its customer. The technology affords the product team the opportunity to communicate 'live' with the end user. This enables the hardware and software developers to anonymously interact with the users as they are using the product, thus gaining unique insight into the strengths and weaknesses of the product. This case also presents an opportunity to compare the product development process as the team moved from a skunk-works type program that developed the first generation product to a more structured second generation process.

Knowing the customer was critically important for this team. Since the original product team did not have any previous 'customers' to study, they did what 'felt right to them'. Interestingly, like many automotive companies developing performance oriented vehicles, the first, and even more so, the second generation product teams were watched closely by the critically important core user group. This dedicated user group presented the team with its biggest opportunity, but also possibly its biggest challenges. These core-users have strong product knowledge. And, much like performance-oriented automotive buyers, they are strongly driven by performance numbers. If the numbers do not match the competition, they are often greatly disappointed, and let their

disappointment be known. It is also important to note that, as with many programs within the automotive industry, the product was guided by a highly influential executive.

The Generation One team was comprised of a very young group that pushed the technology idea through the corporate culture. They did this by creating a skunk-works mentality, with most of the team operating outside the corporate main-stream. It was a very small team working in close proximity, thus communication was simple. Further, with limited resources, the team was forced to be very creative in the development process.

As with many successful skunk-works programs, the successor team was moved into the corporate mainstream. The second generation team was much larger, with greater complexity. Management decided that the program needed more structure, and some method of tracking milestones and communication between shared communication points and hardware interfaces.

The interviewees made a clear differentiation between the industrial design of the physical unit and the software design. The industrial design of the original product was largely determined by component fit. Due to cost and other constraints, the team did not have the option of creating many of the electronic components of the unit. They had to rely on off-the-shelf components. Therefore, the original product was a derivative of the parts. The second generation product benefited from a more mature position within the organization, resulting in more resources and more support. The team had more design freedom with the components, and they could "push the limits more than the original team."

The second generation team wanted to craft a product with a strong industrial design. Art—not science—was the driver for design. Initial shapes were simple and clean. They challenged and encouraged their designers to bring in "cool" products of any type, and spent time discussing and understanding what made those products "cool". The team then worked with story boards full of "cool" ideas to further develop the essence of "cool" and how that would translate into the product niche. For example, black products with stark lines were identified with advanced technology reminiscent of stealth aircraft and Japanese fighting robots. While it may be obvious, this approach, common in consumer products, can have a strong cultural component.

The team then used an outside design competition to develop the unit. Design teams from different regions of the world participated. Several models were then tested in clinics around the world. The clinic participants were not told what the unit was, just asked 'how do you like it?' The Team used elements from two design studies to create the final product. The process appears to have worked. The reviews of the design of the second generation product have been resoundingly positive, with many considering the design worthy of comparison to some recent electronics design icons.

The software design was separate—both conceptually and physically—from the hardware development. Software development is highly creative and, relative to

hardware development, difficult to structure. As such, it is harder to follow a strict product development path. Software development focuses on the application creation. The Team developed a vision of applications, and then determined how they would achieve that vision. The process then forced all involved to identify and chart the critical pathways for the program using a waterfall methodology. Then the project was divided among self-guided teams that were responsible to prioritize their work. The team used a 30-day cycle to assess project progress. As things were done, they were crossed off the list. The process was both time and feature driven. However the key to the success was the understanding that there were many elements of the program that were going to change during the project.

The software developers were also concerned with performance numbers—albeit more subjective numbers. Again, much like the automotive industry, a major driver of consumer electronics sales is the ratings given to the products by key consumer magazine reviews. The software developers took into consideration the focal points of this 'customer base' in developing the operating parameters of their software. (As happens in the automotive industry, they too spent a great deal of time wooing journalists, after the fact.)

The most innovative method of collecting user data was through the use of an interactive service that is managed and monitored by the company. The closest parallel in the automotive industry is that of OnStar. The team members (both hardware and software) used the service to interact directly with their customers, and the customers did not know they were interacting with company employees. Engineers were able to hear and read the unedited responses of their end users. Automotive companies have, in recent years, increasingly relied on customer immersion to better understand the customer. The anonymity of the system takes this immersion further than merely spending time with the customer, removing the bias that may be present when the customer knows someone is watching. This gave them clear insight into specific strengths and weaknesses of the original product, and allowed them to make design changes to the second generation product as they developed it. While the software team used the service to gather information during the development phase, they also used the service after introduction to capture holes in the application and make adjustments to the software after product launch.

A culture in Transition: This was the case of a product development system in transition from skunk-works to a more structured process. The first generation of this product was created by a small, very dedicated team. The team was able to create a product development path that fit their needs. The path this product team has taken is reminiscent of many (initially) successful programs within the automotive industry.

The company has used the second generation product as a test case to refine its internal product development process, including the industrial design process. The company traditionally had a relatively unstructured product development process. Much of the process structure developed for the second generation team was implemented across their hardware development. In this sense, the team represents the maturation of a company's

product (hardware) development system—moving from an ad hoc, personality-driven development program to a more structured developmental process.

This change brings to the forefront an important challenge: how can a company keep the small team mentality while incorporating subsequent programs into the corporate development strategy? In this case, the team adopted a structured approach to the overall project—imposing structure (where there once was little), while retaining the small team feel by dividing the team into subgroups (for subsystems, components and self-guided software teams, etc.). The key enabler for this strategy has been the strict adherence to a web-based product reporting system. Each sub-group was encouraged to create their own process for the development of their portion of the technology but still meet milestones established by the program manager. The program's electronic book included critical interaction points to ensure that the interaction between elements was clearly monitored. This strict attention to the project 'book' was reportedly a critical enabler for the team. While there was some discontent with the structure (by some of the original team members), the general sense was that they had balanced the challenge to keep it small with the need to manage the complexity.

It is worth noting that the relatively small size of the product further enabled the team to successfully undertake this approach. A consumer electronic device, while complex, is magnitudes less challenging than an automobile. Yet their success does present an interesting case study for those looking to integrate a skunk-works project into a more mainstream and possibly repeatable product development system, while maintaining the speed, agility and passion of the original team.

Given the positive reception the product has received, it is apparent the team has been able to capture the essence of that "cool" factor the smaller team created in the original product, as it has moved the process more into corporate mainstream.

Case Study 2 – The Rebel

The following case is from a major North American OEM, which has a very non-traditional view of design and utilizes both traditional as well as non-traditional ways of tracking trends and gathering information from the market.

The most important enabler of their innovative designs is the corporate culture itself. The company actively promotes irreverence to the past, revolutionary thinking and "breaking the rules." Accordingly, there are no "dumb" ideas in the creation of products at this company. Concept ideas are not evaluated on a lineup with benchmark comparisons, but on emotional excitement. The design studios have a flat structure, and the designers are empowered to make many decisions. Thus, the various design groups emulate the culture and nimbleness of a small innovation company. They are free to experiment with both product and process.

Philosophically, they believe the way to determine what kind of a car to build is finding the "white space": identify configurations of vehicles that no one offers and the market would enjoy. Some configuration variables are:

- Price
- Styling
- Performance
- Content (space, technology, passengers, etc.)
- Vehicle type (4-door sedan, truck, SUV, crossover, etc.)

An example of configuration might be to offer an SUV with sports car level handling and performance. Following the Kano model of customer satisfaction, configuration variables should be satisfiers or delighters (Besterfield et al, 1999).

Dissatisfiers cannot be configuration variables. NVH (noise, vibration, harshness) and quality or reliability are examples of dissatisfiers, because they are considered by the market to be a given. Vehicles should not vibrate, be loud (unless that is a characteristic of that vehicle type), have a harsh ride, be of low quality or be unreliable. Dissatisfiers cannot create white space.

Satisfiers are product attributes where the customer feels "the more (or less) the better". Examples are safety, fuel efficiency, and price. Delighters are product attributes the customer was not expecting, or attributes that enable a quantum change in a delighter. Unusual styling and new technology fall in this category.

After the configuration of the vehicle has been identified, one begins to examine the details more closely. There are three major sources that help drive innovation and "cool" factor: suppliers, marketing, and the design group itself.

Suppliers can have a great impact on the design of the interior space and the external lighting. While generally, the responsibility for these aspects belongs to the OEM, they work very closely with their suppliers. One aspect of interiors is they are becoming increasingly equipped with more consumer technology. This proliferation of technology inhibits standardization, which increase costs. Fortunately, technology is converging; more and more functions are being integrated into single units (camera, phone, pda, mp3 player, etc.). This convergence is helping to thwart proliferation, because one needs fewer components and convergence helps standardize the interface between the components resulting in significant cost savings.

Successful suppliers are also developing and selling new technology. Sometimes, this new technology allows radical styling changes, such as LED headlights, ultra thin seats, and transparent roofs. So, it is in the best interest of the OEM to work early and closely with suppliers. Unfortunately, business issues can negatively affect these relationships. Purchasing, legal departments, competitive cost pressures, and a negative company culture can provide disincentives for suppliers to innovate or work closely with their customers. Successful OEMs involve their suppliers early and develop a process and infrastructure that inspires them to innovate and enables them and the OEMs to adapt quickly to changes in technology and the market.

Market research is another very useful source of future trends. However, this company's research is different than traditional market research. They are not simply looking for market acceptance of a particular design or product. Rather, they are trying to understand what aspects of the design evoke a strong emotional response. The market research team has developed a unique and effective method of determining whether a particular design evokes an emotional response. They do not simply ask questions such as: "do you like the car?" They try to determine what resonates with the customer and why. Is there an emotional tension because of positive or negative attributes? How can the negative attributes be corrected? Why are they negative attributes? The analysts delve deep into the data to determine whether there was a bi-modal response (people either loved it or hated it, but nobody was in the middle). This may be the sign of a good design, as it shows emotional tension. Conversely, if the emotion is uniformly positive, is it because of familiarity with the particular attribute? This may not be good for a design, as familiarity does not necessarily generate a strong emotional response and may be considered boring by the time the vehicle is released to the market.

Balancing the market research is a concern about obtaining too much data and a healthy reluctance to rely too heavily on analysis of market trends. One can lose sight of the uniqueness of a design by overanalyzing it, or the market. Further, formal data analysis is often very time consuming. The marginal benefit of extensive data analysis does not generally justify the time spent. And relying too heavily on time consuming market analysis is counter to the small company culture of nimbleness and rapid response to market changes. For example, there is currently no formal large scale monitoring and text analysis of blogs. Software is being developed for this task but is still limited in its analysis and application in design.

In the end, the design group has to take all the available information from suppliers and market research and combine it with their own research. The design group has the tough job of designing vehicles for a wide demographic of purchasers. "Cars are purchased by people from 30 to 60 [years old]. This presents a unique challenge." The designers are provided considerable freedom as to how they create and where they get their ideas. They use their own personal preference for inspiration, based on their hobbies and interests. They often attend tradeshows, such as the consumer electronics show, and monitor technology. Others might go on architecture or fashion field trips to obtain inspiration for form and color.

The company also competitively benchmarks their competitors' products as well as the products of their suppliers and the suppliers of their competitors. This is a fairly common practice and is very effective to understanding future trends in the industry.

The design teams are also using electronic media in novel ways. The advanced performance group often uses blogs and creates on-line interviews with fans. This direct electronic interaction with customers is similar to the interactive service used by the players in case 1. In this case, it is direct, identifiable, one-on-one interaction between specific designers and customers. Therefore the interactions are with fewer customers, and the customers know they are talking to designers. Customers are very enthusiastic

and get very excited when they can talk with the people who are designing or have designed their cars. It creates a very personal relationship between the customer or driver and the designer. The fans are both a great source of inspiration and motivation for the designers.

The above examples show how a small company culture enables the design team to experiment —not only with different product ideas but also with different methods for understanding the market, obtaining ideas from different sources, experimenting with ideas, and interacting with the market to validate the ideas. Ultimately, the design requires the individual designer to go out and personally get the information (through blogs, the market research group, interaction with other groups, etc.), form his/her own opinion (perhaps expressed in a design), and communicate this opinion with top decision makers. Of course, the decision makers have to have good instincts as well.

Even in a small company culture, the creativity process has to be managed and business decisions have to be made. Key suppliers are involved from the beginning and are co-located with the design team. Engineering and marketing are also involved. The group (approximately 40 people) meets weekly to coordinate and make decisions. There are many face to face meetings to coordinate details. And while email and other electronic forms of communication are common and used extensively, the more advanced collaborative design tools such as application sharing or net-meetings are not used as much. This is because the team is not geographically dispersed. There is a sense of being able to more rapidly exchange information and come to a consensus decision on many issues (both large and small) when the team is colocated. This is partly due to the richness of the information exchange that face-to-face meetings allow, as well as the ability to coordinate on an unscheduled basis without having to wait for the next scheduled meeting. Both application sharing and net-meetings require coordination between the meeting participants. Thus, a key aspect is to keep the team small and ensure that it consists of critical participants.

Case Study 3 – The Fast Follower

While this project is intended to investigate non-traditional informational pathways, one OEM interviewed strongly believed that it was not about the information, arguing that most are very similar in their information gathering. Instead, it was the corporate culture of processing the data. This company preferred to highlight the corporate culture that encourages the development of desirable vehicles.

According to the OEM representatives, many ineffective companies are risk averse. They have developed corporate cultures that discourage risk-taking and encourage status-quo. They gather massive amounts of data, and don't apply common sense to the data. This is a theme that was also mentioned by the Rebel in case 2.

Several times the representatives referred to the 'Boeing 80/20 rule'. That is, 80 percent of the decision inputs are made on gathered data, and 20 percent is intuition. It became clear that they believe corporate 'knowledge and experience' (or intuition) are important differentiators. While this points to the importance of people within an organization, it

also highlights the human resource challenge: that of keeping the competitive edge—i.e., the 'knowledge'—within the company should an employee leave.

The respondents believed that most automotive manufacturers used the same pathways to gather data and all were able to gather enormous amounts of information. In fact they suggested that the real challenge was eliminating the noise and understanding what pathways and messages were the important ones. For example, many companies now use customer immersion as a key part of their product development input. The company interviewed also uses such techniques. However, while they agreed that it is important to understand how the consumer uses his/her vehicle, they felt it is essential to know how to utilize that understanding in the product development process. They argued that it was the ability of the product development team to process the data that made the product a success.

While all companies 'listen' to the customer, the interviewees pointed out that the customer often 'lies, or makes misleading inferences'. Looking for contradictions in the consumer data is essential to the company's product development process (for example, the rebel company in Case 2 looked for design tension—difficult to define, but critical to capture). Thus, the company must use the intuition of the team to interpret what the consumers are really saying, or not saying.

Yet, consumer data is not the only tool. According to one interviewee, 'this is not rocket science'. When analyzing the marketing data, it is essential to use 'a lot' of common sense (again, referring to the 80/20 rule.) The company puts all the data together and makes a decision. According to the respondents, one of the strengths of the company is that all of their people like cars. They have experience, but they also have passion. That passion sets the company apart. Such a decision process seemingly puts a high value on the accessibility of data and communication as an enabler to leverage intuition.

The organization believes itself to be a 'fast follower'. It studies others in the industry very closely. It is possible that the data gathering needs for a fast follower are different than those of an innovator. The fast follower can rely more on 'traditional' customer data—and competitive benchmarking—than a company that is trying to identify white space in their product portfolio. It will be interesting to see how the company works to develop non-traditional information channels as the they move to introduce vehicles into identified 'white space' in the coming years.

The company representatives stated that they pick extremely high bogeys for benchmarking. The interviewees believed that some companies choose benchmarks that are easily attainable, and thus deliver a vehicle or component system that does not reach beyond the competition. The ability to push the development team to create better, cheaper vehicles and components faster was enabled by the lofty benchmarks chosen—for example, selecting a luxury car as the bogey for a mid-class sedan, or a class leading mid-class sedan as the mark for an entry sub-compact. It instills a stress in the organization, and forces everyone to reach higher than otherwise could be expected.

This company is driven by a culture of being the underdog. There is a constant pressure to 'catch' the competition and deliver better, less expensive alternatives. One of the strengths of the organization, as identified by the respondents, was the ability to confront problems immediately. According to the interviewees, some companies fail to confront disastrous problems or programs. This is because corporate culture within these companies has created an environment of individuals unwilling to step outside of their comfort zones, and raise issues that need be corrected. The reward/punishment mechanisms create an environment that makes people risk averse. Even worse, according to the interviewees, the lack of problem identification and resolution allows people at these companies to agree to make changes in the traditional ways, and then proceed down their own paths—whether or not it is in alignment with the decisions of the team

The product managers have a pretty good idea of what they want to change from their own experience with the product. This information is combined with knowledge of the competitors' products, and the company's own strategic plan. Then, they make the decision and support it with data. Strong personalities are involved in the process, combining "common sense" with data to reach a decision.

Representatives from this OEM suggested that their company was very focused on including only those in the decision process whose input was necessary—or 'Top of the Food Chain' consensus. This makes for very action-oriented meetings/discussions. For example, if there are only three people whose opinions matter, there are only three people in the meeting. Thus, consensus is more quickly reached, and the program team is instructed how to move forward. According to the respondents, those that are working on the program (engineers, suppliers, etc.) do not deviate from the path set by program leaders.

The corporate culture was described as very Darwinian—it gets rid of those people that are not car-culture oriented. Everyone strongly cares about the customer, the company, and the product. There is a lot of informal, but focused, dialogue between the employees, aimed at bringing issues and problems to the surface quickly.

Innovation is of growing importance at the company, which is committed to organically developing key technologies in-house. Therefore, they are making a strong effort to educate their engineering staff. The respondents often referred to the company as a learning organization. They also felt they were very quick learners. One element of learning was to ensure that mistakes are not hidden. Speaking from past experiences, a respondent suggested that some companies fail to confront their mistakes. Corporate culture at these companies often fails to deal with a disastrous program because no one wants to step out. Instead, many within these organizations would ignore the problem and push forward. Accordingly there is no incentive to raise red flags.

It was acknowledged that their ability to react quickly, to have a Darwinian culture, and to be a fast follower, is also in part because they are a small company. They quoted the ratio of the number of people in the company per cars sold as a metric of size and organizational efficiency. In smaller companies, there are not as many people to consult

or that might obstruct or simply slow down decision making. Further, communication between people is simplified in smaller companies. In fact, frequent and informal communication between individuals was listed as a key factor in being able to identify and resolve issues quickly. In particular, frequent communication between marketing and engineering was emphasized. Marketing would quickly carry the voice of the customer (VOC) to engineering, which was responsible for implementing the VOC.

There is also a great deal of electronic communication within the organization. E-mail and video conferencing were mentioned as common techniques, but it was noted that all 'big decisions' tended to be made in face-to-face meetings.

Another aspect of a small company is that one cannot hide. This was described as similar to living in a small town where everyone knows everyone else. Everyone at this company knows what everyone else is doing. Because of this small town mentality, they all quickly know if there is a problem, making hiding it all the more difficult.

According to the interviewees, most companies do not adapt quickly enough to the market. Constant change to market conditions is a strong part of their corporate culture. An example of a recent product introduction reflects the willingness to change. In this example, marketing pushed engineering to make significant and costly changes to the component of the vehicle, one month before product launch. The changes gave the vehicle unique characteristics within its segment, and thus became a sales differentiator. They are also not afraid to make running changes during a program if the organization has identified a need.

The authors find it interesting that common thinking within the automotive industry is to minimize change later in the development timeline to eliminate costly retooling. Although this company also attempts to reduce late changes using a rigorous product development strategy, it realizes that change can be pushed though late in the program. As was clearly explained, while changes made late in a program are expensive, they are not nearly as expensive as not making the change and delivering a product that is in some way flawed. The cost of incentives, and a tarnished image, are likely far greater than the cost of any late changes in the product and process. However, one could further suggest that the identification of the fault at an earlier stage would be more effective.

The interviewees also felt that a close relationship with their suppliers made these late changes possible. While the changes brought challenge to the suppliers, they all were better off making them and delivering a stronger product. It was important for this company to have a highly nimble supply base. Therefore, they worked closely with select suppliers to gain the competitive advantage of a vertically integrated company, without having the financial risk. These suppliers are selected not only on performance but also on a compatible culture of quick response to changing customer needs and an aggressive approach to fixing problems. As such, these suppliers are also often small, nimble companies.

Case Study 4 – The Technology Pusher

The methods and channels used to gather information for a startup company that developed a novel technology are by nature different than those used for either existing companies or established technologies.

This case study involves a company that is both an outgrowth of a specific technology as well as its environment. This company developed in a decidedly hi-tech focused region, with a strong history of working with related hardware technology applications in other sectors, (e.g., defense). Further, the region's workforce is highly educated with both a strong entrepreneurial spirit and a global business perspective, due in part to their limited opportunities to sell in the home market or to immediate neighbors.

The original core technology was developed by a degreed research scientist. This person developed a unique approach of combining hardware innovations and advanced mathematical algorithms to create an advanced data collection technology that was several orders of magnitude faster than existing technology and robust to environmental factors. This person sought a market and financing with which to further develop the technology by attending trade shows and by talking with investors. This example is a clear case of technology push rather than market pull—not uncommon when the technology is something the market cannot yet envision.

While the innovator worked on developing the technology for several industries, the initial response, (i.e., funding), came from a friend in the automotive industry—thus, the technology was first developed around automotive applications. A venture capital firm provided further seed money. In hind sight, there was a concern that because the early development was funded by automotive, the organization may not have fully explored other applications for the technology. The fact that early funding guided the technology into a particular application may have been a limiting factor and detriment to defining a broader and more profitable technology path. On the other hand, the targeted application environment allowed the company to develop a deep understanding of the customer's needs.

The first generation implementation was based on an algorithm layer that rests on the core technology (see Figure 3). The management team was recruited from companies that had a background in the core technologies applied in other industry sectors. After the initial deployment, the team made the conscious decision to focus their entire efforts on the automotive sector. Further, they adopted a multi-layered "full service" strategy to meet the market's needs.

The primary source for understanding the market and its needs came from this company's own customers. Knowledge about the market continues to be gathered through the customers. The company identified the system's shortcomings, and developed new technology that provided them with a competitive advantage. For example, the next generation of product focused on improving the functionality of the data analysis software (Embedded Software Layer in Figure 3). The ideas for many new software features offered originated from spending time with the equipment operators, data users,

and data analysts. As the technology was deployed, the company's field representatives encountered people who used all or portions of the data analysis results. These people were often at other geographic locations. Thus, the company developed off-line software applications that enabled people to store and access the data and analysis results and conduct additional analysis more efficiently. The company continues to develop additional technology based on customer needs and failures.

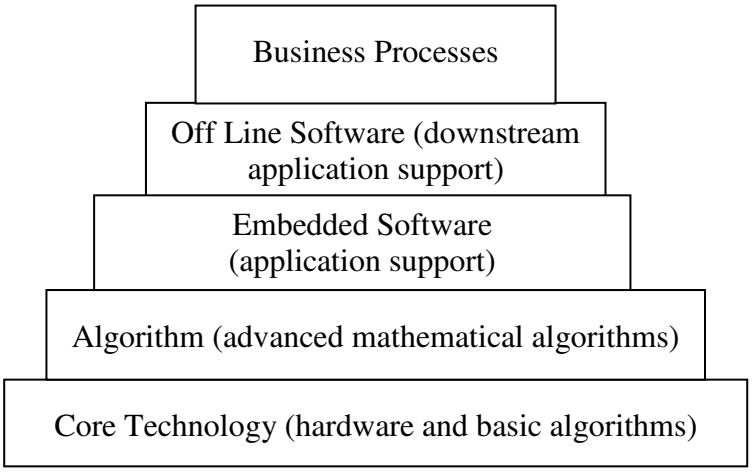

Figure 3. Layered Business Model

However, this company does not simply focus on the technology—they also focus on the process. They have personnel who work with customers to develop new business processes to achieve strategic changes enabled by the technology. This "cradle to grave" understanding of the customer's objectives, processes, personnel, and available implementation resources has provided the company with a significant competitive advantage. By developing these layers, the company has a fully integrated process. While there are competitors in each layer of the business, and some that focus on two layers, there are none that offer the 'full service' strategy.

As has been stated previously, most of the company's market intelligence is gained from their customers. The company does not employ focus groups, marketing consultants, or other avenues. They keep in contact with all of their customer companies, as well as their competitors, supporting technology companies, and the like. This is a market with a lot of "coopetition." For example, the company may cooperate in one geographic market with a software company that is a competitor in other another geographic market. Also, as the barrier to entry into the automotive market is significant, (an automotive implementation can take several years), the company learns about new competitors quickly.

The company's layered business strategy also changes their view of competitors. Sometimes competition comes from a different area of the application domain. Because they are working more and more in the vertical application domain—including data capture, data analysis, data storage, and business process development—the company views the entire application domain as its competitive arena. A suitable analogy might be a vehicle itself. The core technology would be the powertrain, where there are many

competitors. However, this company would expand into other layers, (e.g., the entire vehicle), where there are now fewer competitors. The next analogous expansion would be dealerships, repair services, or driver education.

The company does not rely on competitive benchmarking as an information channel. While the company does benchmark the hardware at the core level, their strategy is not to sell by feature comparison of the core technology. The reasons are twofold: first, they feel no similar technology exists, and therefore strict comparisons are not possible, and second, they offer a vertically integrated service of which the core hardware technology is only a portion. Many of their competitors offer only hardware. Benchmarking plays to the competitor's strategy, not the company's.

Product development at this company is driven by the creativity of the people and the customer/user experience. The company believes it has a uniquely creative staff that is focused on bringing innovation to the market, and their personnel represent the customer through ongoing interaction. These two inputs (staff innovation and customer requests) are used to create a laundry list of technology requests that are prioritized and cross referenced with strategic initiatives or opportunities. The company uses this matrix to identify the "gray-space" of the potential product development path. They then utilize in-house customer experts to assess what—or if—the customer would be willing to pay for the added feature.

Lastly, the company relies heavily on global partnerships with like-technology companies and technology-specific bi-lateral industry groups, and also participates in numerous research projects involving academic institutions around the world to validate and create ideas. Contrary to some other case studies, they do not feel their supply chain is a valuable information source. The hardware suppliers are far removed from the customer and only supply hardware and services at the lowest layer. At higher layers, there are no suppliers in the traditional sense, but rather partners and competitors. Sometimes they are one and the same, as mentioned above.

DISCUSSION AND ANALYSIS

The intent of this paper is to investigate some of the major factors contributing to successful product development. In particular, we were looking for differences from the standard approaches. In this process, we found (not surprisingly) some factors that are well known and documented in previous literature. However, it is instructive to note, in these changing times, which lessons from the past have been maintained and which have been abandoned.

The major conclusions are:

- Size matters - all respondents believed that small groups were most effective—even necessary—for delivering "cool" products.
- Variety of information channels – different respondents had different ways of obtaining a true understanding of the customer.
- Data is not everything – despite the increase in available data, the data-driven design process of the '90s is out. A decisive leader with product passion and customer awareness is key.

Size Matters

Everyone mentioned the importance of being small—or at least the ability to behave as a small company would. This factor is extremely important (Hamm, 2006). While the benefits mentioned by the respondents have been well documented in previous work, it is interesting to note just how important this factor seems to be within product development. One should contrast this with other factors that may be important, but were not mentioned in the case studies—such as following a disciplined product development process, global engineering, or computer-aided engineering tools. One can conclude that these factors, while certainly important, are not as important as size. This is a significant conclusion.

The major benefit of a small organization is in the speed of communication between team members and with decision makers. When the organization is small and communication quick, decisions can be reached much more quickly, enabling faster action. This, in turn, provides additional time to undo mistakes (if necessary), enabling a stronger culture of risk taking and innovation.

For smaller companies, such as the technology pusher, this is not a major issue. For the large companies, it is a challenge to create a small company culture within product design. The rebel OEM created a company culture and management structure that promotes small company behavior by creating flat management structures, delegating a great deal of decision-making control to lower levels, and encouraging people to think about and to do things differently. Of course, the team must still interface with the larger bureaucracy on program financial, timing, and planning issues, but the general decision-making balance was towards autonomy of the individual design groups.

The Players were being pushed by the corporation toward making the product development effort "large," while the development team was fighting to remain small. In this case, they appear to have struck a balance between the two through a high level structure with defined key interface points. This allowed smaller teams to decouple and behave like small companies, interfacing only at the previously defined points. This strategy can work if the product development can be sufficiently decoupled and the number of interface points kept to a small workable minimum. The player company must guard against over-formalizing the product development process in the future. The company's product development efforts will fail if management creates "large" product development structures. They must be cognizant of creating a small company culture and an infrastructure that supports such behavior to continue their successes.

Two critical elements to the fast follower's company culture helped them achieve the agility and speed of a small company (they perceive themselves as a small company). First, they were driven by a culture of being the underdog. There was a constant pressure to 'catch' the competition and deliver better, less expensive alternatives. This led to an innate appreciation of speed throughout the organization. This embodied itself in numerous ways. For example, communication was direct, concise and pointed. The company assured fast meetings by inviting only those who could make decisions regarding the issue at hand. Those in attendance were expected to have reviewed the

information prior to the meeting and be ready to make a decision. Once a decision was reached, there was no second guessing and everybody worked in a coordinated fashion, based on that decision.

Second, the company had what was described as a "no fault" attitude. Making decisions rapidly was viewed as important, but identifying and rectifying problems and errors quickly was equally important. The culture was to reduce—even eliminate—the fear of blame, and replace it with an atmosphere of identifying errors and correcting them as quickly as possible. Driving out fear is Deming's 8th point of management (Deming, 1986).

As mentioned above, the major benefit of small size is increasing the speed of communication. This is important, because improved communication enables closer collaboration both within and between organizations. However, collaboration is not a natural act, and it requires tools, processes and interpersonal relationships. Organizations are constantly working on increasing collaboration between engineering design and manufacturing, purchasing, and suppliers.

The companies interviewed all pushed for fast communication of critical knowledge. They also strived for open, two-way, communication. Small organizations/teams, often co-located, allowed for swift two-way communication of high density information.

However, co-location is not the only option. In a recent Product Development Delphi study (CAR, 2005); the greatest enabler of collaboration and the biggest factor contributing to product development success were the new internet-based electronic communication tools. The technology has changed the way people communicate; this trend is expected to continue in the future, especially as web-based collaboration tools proliferate and gain acceptance in the industry. These tools accelerate the speed of communication and enable people to make better decisions (because they are getting only the information they need) faster (because it is communicated electronically). But, one should note that here too, there are different levels of communication tools. There are tools designed to allow collaboration through shared applications, such as CAD design, etc. Typically, these tools require coordination by all parties, similar to setting up meetings. Then there are tools that are more flexible and operate either in real time or are time-independent, such as email and instant messaging. It is these latter tools that are seen as major process accelerators.

All respondents emphasized co-location and none mentioned the electronic tools. We believe this is for three reasons. First, email, video conferencing, application sharing, etc. are now commonplace and everyone uses them. Therefore they do not need to be mentioned. Second, the people interviewed were all of approximately the same generation. They are comfortable using a certain set of technologies. The next generation of workers and managers will be even more internet savvy and accustomed to having multiple instant messaging (IM) sessions while checking email and completing their work (Hempel, 2005). They will be meeting in cyberspace to play on-line games rather than meeting on the green to play golf (Hof, 2006). These developments will

loosen the bonds of colocation. In particular, IM is considered to be similar to meeting someone in the hall, even if they are across the building or across the globe. Widespread use of IM may be the next level of communication that will speed the productivity of human endeavor. Third, these electronic communication tools cannot completely replace face-to-face meetings. Physical meetings are superior when one must exchange a large amount of complex and subjective information. Team building through working together, strategic planning, negotiations and conflict resolution are some of the typical situations requiring such exchange of high information content. In these and similar situations, it is necessary to build a sense of trust and understanding which is most effectively achieved through face-to-face interaction.

Variety of Information Channels

Having a deep understanding of the customer is almost a cliché. The real questions are: how is that understanding obtained and what information channels are used to obtain that understanding? There is an increasing recognition that traditional focus groups and customer observation are insufficient (Hamm, 2006), and that data-driven product development methods have their limitations with regard to achieving a deep understanding of customer needs.

At each company, there was a deep understanding of their customers. Most all used traditional methods, such as focus groups and competitive benchmarking, to understand the market. However, there were some methods that were unique to the particular companies and a function of their particular company cultures. These alternatives all attempted to lead the designer to a deeper understanding of the customer-product relationship than even the everyday user has. The designers had to be able to ask themselves the questions that the consumer could not answer. It has been often noted that the consumer frequently cannot express what they truly need or desire.

The Player team was comprised of a mix of technology people and product users. By having dedicated users on the team, there was immediate feedback to product issues as the program developed. In an important way, these users provided a critical voice of the customer to the program, and in doing so, brought an increased tension to the program along with a focus on the engineering specifications. There are similar parallels in the automotive industry. For example, the original Dodge Viper development team included several sports car racers, motorcycle racers, and drag racers. Each brought an understanding of the need for converting engineering specifications to performance attributes and a familiarity with cost constraints, late nights, and deadlines (Sjoberg, 2006).

The team also encouraged early and frequent interaction with their core users and the influential product reviewers. According to the interviewees, this interaction was early, continuous and direct. They attempted to interact as directly as possible with these customers. The team also gathered user input through a limited review of web-based chat rooms, mostly on corporate websites.

The mission for the rebel team was to look at things differently, and then do things differently. This led to the search for tension—in everything—but especially in design. Thus, the challenge for this company was to manage tension in the product and the development process. Team members were encouraged to search out tension in their surroundings, with the intent of bringing it to their work. They used market focus groups to identify styling elements that created tension—often times, so subtle, the customer did not overtly recognize it but could feel it. The marketing group had become very adept at setting up these studies to elicit and identify these tension points. The team had to interpret that tension and determine what the tension meant, how it was created, and whether the styling element was essential to the product or should be modified or eliminated.

Some designers spent time reviewing web-based chat rooms, and web logs—specifically those aimed at their performance vehicles. They would also chat, blog, and email with fans to elicit dialogue. This created a feeling of closeness between the customer and the designer. "There is nothing "cool"er than being able to chat with the designer of your favorite car."

One can see how the internet is impacting the design of products in ways unimaginable only 10 years ago. The important characteristic here is that it is used to obtain a better understanding of the customer in a very direct and visceral manner.

The fast follower team strongly believed that their product intuition was a critical corporate strength. They indicated that they worked to understand the customer, but had to go beyond the data to be successful. They gathered information from a variety of sources (dealerships, marketing, benchmarking, etc.) and made it a point to quickly act on that information. While the respondents indicated they used data gathering extensively, they believed what set them apart was their product expertise (knowledge about the product) and their experience as product users (knowledge about how the product is used). They further believed that they had a very good understanding of the competitive benchmarks, and used that knowledge to ensure that their product would be perceived as a strong entry. Like all of the companies interviewed, this team relied heavily on market knowledge—the balance between understanding what the customer says and what the customer doesn't say. They did not use web-based channels like those mentioned by the Player or Rebel teams.

The technology push team worked with the customers on their installations and actually "walked the walk." They performed the work first at the customer's location. This provided them first hand experience in what the customer had to do every step of the way. Not only did they experience how well their product performed (or did not perform), but they also gained an understanding of the true problems the customer faced and why the customer was doing this particular task or work. This, in turn, offered them insight to the purpose of the work at the next higher level. Based on this insight, as well as explicit feedback from customers on how their products were being used, they would improve and expand their product and services. They had a passion to expand the system by always looking at ways to add value. They continually attempted to perceive the next

level of use. They focused not only on the immediate tasks and technology but also on the higher level purpose, the processes, and the people. While this approach does not rely heavily on a web-based communication or technology, it does allow the company to obtain a truly deep understanding of the customer, at all levels.

Data is not Everything

Historically, the product development process transitioned from being heavily influenced by specific individuals in the '60's and '70s to being influenced by data-driven cross functional engineering teams in the '80s and '90s. The understanding of the speed-to-market concept required that everyone develop simultaneous engineering systems. Further, the data-driven decision-making mentality of the quality movement was pushed into product design. Much of the data was obtained by marketing, giving marketing tremendous power, and limited (to some degree) the power of design. We are seeing a backlash against these trends, as product development has again gained preeminence.

All the companies acknowledged the need and utility to gather and use data. Clearly, data is knowledge, and knowledge is power. However, there are limits. For example, design teams do not appear to use software capable of tracking many websites and blogs, (e.g., software designed to track customer satisfaction or warranty concerns). This might be because it is simply too difficult and time consuming to translate the software output into specific design recommendations. Alternatively, the software may only provide aggregate market information that does not allow the designer to develop a deep personal understanding of the customer. With the rapid change in software, this situation could change in the future.

All companies emphasized that data was not the sole driver of their decisions. There is a need to have decision-makers who are passionate about the products and have insight into the market that cannot be captured by data. To this end, none of the companies relied solely on data or felt beholden to it. Instead, they used that deep knowledge of the market to assess the data and then go beyond it. This leads to the concept of a chief engineer that makes his/her mark on the product based on data, but not to the exclusion of all else.

Often times, successful programs within the Detroit Three have been driven by a personality, or a team of personalities, that takes the product under its wing, and guides it around the constraints of the corporate product design process. High visibility examples of this include the original Ford Taurus, a program in which Lew Veraldi, Chief Engineer, created a cross-functional team to design, develop and manufacture the Taurus. Unfortunately, while Ford tried for years to incorporate Veraldi's concepts into their product development system, they were not able to capture the effectiveness of the original Taurus program. The Dodge Viper, a program enabled by Bob Lutz and run by Roy Sjoberg, was a small, under-the-corporate-radar team that was able to drastically reduce the cost of development and time-to-market while delivering a very well-received vehicle. Many of the lessons learned in that program were not successfully integrated into the Chrysler product development system. More recently, one can look to the Pontiac Solstice. General Motors has gone to great lengths to show how a small product

development team was given authority to go outside the system and create a new pathway for development. The company has also made clear that they hope to take the lessons learned from the development of the Solstice and implement them into the corporate product development process. It remains to be seen how they will fare.

The chief engineer is a significant human resource issue. The organization must develop an infrastructure that consistently develops chief engineering personnel (Morgan and Liker, 2006). While not everyone must become a chief engineer, there have to be sufficient engineers to lead the variety of programs. The history of the Detroit Three has not been encouraging in that respect. Sometimes they simply hire externally, but this is an unsatisfactory, risky, and potentially expensive proposition. It is far more desirable to develop the infrastructure capable of identifying, preparing, rewarding, and retaining talented individuals for the position of chief engineer. This is a major challenge that many companies must face.

Lastly, it was apparent that the people were expected to know (and care) how the product was used. This commitment goes well beyond the long standing 'listen' to the customer, and borders on passion for the product. Each of the companies encouraged—even required—their people to have a creative passion for their product. While one of the companies interviewed suggested that 'most' of the team members were passionate about the product, the other companies said that passion for the product, or application, was part and parcel of their success. This deep caring for the product and the end user was the cornerstone of each company's success.

CONCLUSIONS

This study investigated some of the structure and information channels used by four companies to create "cool" products. While there were distinct differences between the companies—both at the fundamental as well as the detailed level—three major conclusions were drawn.

1. All four companies had product development teams that behaved like small, nimble entities. This enabled faster communication as well as innovative and risk-taking behavior.
2. All four companies established different information channels in addition to the traditional methods of focus groups, competitive benchmarking, and customer observation (such as direct internet-based interaction with the customer) to obtain a deeper understanding of the unstated customer needs and desires.
3. All four companies had product development teams with strong leaders making decisions based on a combination of limited data and their understanding of the market. The teams did not focus on trying to justify every decision with data, or waiting for data to make a decision.

These three aspects together form an environment where people can fail. If employees are encouraged to take risks, make decisions based on data (albeit incomplete data or small sample size data) and trust their own insight and beliefs, then it is likely that individuals will occasionally make risky decisions that do not always lead to success. However, with increased speed and agility and a corporate culture that eliminates fear of retribution, the individual will own up to the consequences and the organization will have the time for corrective action. The

major benefit is the learning gained from the mistakes. Often, one can learn more from one's mistakes than one's successes. This is also true for organizations (McGregor, 2006). And any organization that can increase its speed of learning will have a significant competitive advantage.

As companies continue to reduce their time-to-market and increase their responsiveness to market and business environment changes at a global level, flexibility and speed are key organizational goals. There are many initiatives, strategies, technologies and factors that have contributed to an organization's ability to be fast and flexible. This paper, using a case study approach, attempts to show how some companies' corporate cultures combined with specific information channels are instrumental in creating "cool" products in today's challenging automotive climate.

A successful company must create a corporate culture that elicits the nimble and agile behavior of a small company within its product development teams, without stifling their creativity with the larger company's need for control. Fear must be eliminated. The organization must eliminate its fear of failure and the individuals' fear of retribution; excessive bureaucracies are often an attempt to control risk and, as a result, they slow an organization's ability to respond to opportunities. The company must initiate innovative information channels to better develop a deep understanding of the customer through direct interaction with individual designers on the product development team. This benefits the designer and can have a positive effect on the market, if the interaction is not anonymous. Lastly, a successful company must develop the infrastructure to identify, groom, and retain leading personnel for the chief engineer's position. These people will be key to the organization's rapid response to market forces with "cool" products.

REFERENCES

1. Besterfield et al, Total Quality Management, Prentice Hall, 1999.
2. Center for Automotive Research, Product Design and Development Delphi, Center for Automotive, 2005.
3. Deming, W. Edwards, Out of the Crisis, MIT Center for Advanced Engineering, Cambridge, MA, 1986.
4. Hamm, Steve, *Speed Demons*, Business Week, March 27, 2006, pp. 68-76.
5. Hempel, Jessi, *The MySpace Generation*, Business Week, Dec. 12, 2005, pp. 86-96.
6. Hof, Robert D., *Virtual World, Real Money*, Business Week, May 1, 2006, pp. 72-82.
7. McGregor, Jena, *How Failure Breeds Success*, Business Week, July 10, 2006, pp. 42-52.
8. Morgan, James M. and Liker, Jeffery K., The Toyota Product Development System, Productivity Press, New York, 2006.
9. Office for the Study of Automotive Transportation, Product Design and Development Delphi, University of Michigan Transportation Research Institute, 1998.
10. Sjoberg, Roy, *Personal Interview*, Center for Automotive Research, June, 2006.